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MEASURES OF AQUITARD INTEGRITY

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Aquitards are perhaps the most important yet most poorly understood components of groundwater flow systems. Aquitards control recharge and contaminant transport to adjacent aquifers, but methods for assessing their physical properties are not well developed. Although many public water supplies draw water from confined aquifers thought to be well protected by overlying aquitards, rigorous data collection to verify aquitard integrity (including hydraulic conductivity, continuity, and homogeneity) in the context of groundwater protection is rare.

In an extensive review of the literature, we found that many textbooks present an oversimplified view of aquitards, usually depicting them as thick, laterally extensive uniform units. In contrast, detailed field studies commonly demonstrate large spatial variability. Textbooks frequently depict aquitards encompassing entire geologic formations or stratigraphic units, while in fact only a key zone in a stratigraphic unit is hydrogeologically important and "does the work" in providing the aquitard's protective capacity. With only few exceptions, pumping tests to assess aquitard properties and leakage include little or no monitoring within the aquitard, and predict aquitard properties from aquifer response. This provides little value or is misleading in the contaminant migration context.

The most important field data to collect for assessment of aquitard integrity is vertical or angled profiles of hydraulic head versus depth within the aquitard. These profile measurements should include depth-discrete and temporal head data and be complemented with geochemical and isotopic indicators from the aquitard. Head profiles collected from aquitards composed of shale in Wisconsin and clay in Florida and Ontario show that large head drops typically occur over only a small percentage of the total aquitard thickness. In some cases the vertical hydraulic gradient across the tighter zone greatly exceeds one, although the gradient across the entire aquitard is less than one. The main protective capability of these aquitards is provided by these thin zones of large head decline, and therefore the task of determining aquitard integrity should be focused on these thin zones and their hydraulic properties, extent, and continuity, rather than the larger geologic unit.